

Redesigning Pork by Type and Amount of Dietary Fat for Better Human Nutrition

A. D. Penner, graduate student,
M. L. Kaplan, professor of human food and
nutrition
D. C. Beitz, professor of animal science and
biochemistry
Department of Animal Science

ASL-R1423

Summary and Implications

An experiment to modify pork by supplementation of dietary lipids yielded the following conclusions: 1) Supplementation of pig diets with high levels of lipids did improve feed conversion without affecting other growth performance characteristics. 2) Feeding of choice white grease increased the content of monounsaturated fatty acids in skeletal muscle and adipose tissues of pigs. 3) Feeding soybean oil, increased the content of polyunsaturated fatty acids in skeletal muscle and adipose tissues of pigs.

Introduction

Increasing dietary saturated fat causes hypercholesterolemia and raises the risk of atherosclerosis and coronary heart disease in humans (Keys, 1984; Rudel et al., 1986; Oliver, 1987). Substitution of dietary polyunsaturated for saturated fatty acids decreases the concentration of blood cholesterol (Grundy et al., 1982; Nestal, 1987). This information causes many consumers to question the consumption of meat products, such as pork, which is perceived to be high in saturated fatty acids. Fatty acid composition of porcine adipose tissue is influenced markedly by the fatty acid composition of dietary fat (Skelley et al., 1975; Wood, 1984; Miller et al., 1990). Therefore, a decrease in the amount of fat in the carcass of pigs and a decrease in the proportion of saturated fatty acids to unsaturated fatty acids would make pork more acceptable to health conscious consumers. The objective of this study was to determine the effects of adding choice white grease or soybean oil at 10, 20, 30, or 40% of total calories to growing finishing swine diets on growth performance, carcass composition, and fatty acid composition of subcutaneous and muscular lipids.

Materials and Methods

Animals

Fifty-four crossbred barrows and gilts, approxi-

mately 19 weeks of age and 54 kg. body weight were assigned randomly to nine groups so that breed, gender, initial body weight, and litter origin were equalized among the groups of six pigs each. Each group was assigned randomly to one of the nine diets described in table 1. Body weight and feed intake were recorded weekly.

Diets

Ingredients and nutrient composition of diets are shown in table 1. The corn-soybean-based diets were supplemented with either choice white grease or soybean oil at 10, 20, 30, or 40 percent of total calories. Dicalcium phosphate, calcium carbonate, and a trace mineral and vitamin mixture were added to meet or exceed daily requirements for growing pigs (NRC, 1988). Fatty acid composition of choice white grease and soybean oil are given in table 2.

Sample Collection

At approximately 111 kg. body weight, pigs were slaughtered humanely at the Iowa State University Meat Laboratory after a 12-hour fast. After viscera removal, a sample of perirenal adipose tissue was taken from each pig. Carcasses minus perirenal adipose tissue were weighed and then chilled at -2°C. At 24 hours postmortem, backfat thickness and longissimus muscle area, color, marbling, and firmness were obtained by using standard procedures (NPPC, 1991). Skeletal muscle samples were taken from the longissimus muscle (10th rib), the biceps femoris muscle, and the triceps brachia muscle. Adipose tissue samples were collected from sites adjacent to the longissimus muscle (10th rib, inner, middle, and outer layers of backfat were separated at the visible connection tissue septum), the biceps femoris muscle, the triceps brachii muscle, navel area of the belly, and an internal intermuscular deposit within the ham. All samples were removed at 24 hours postmortem and stored at -20°C until analysis.

Analyses

All samples of feeds, skeletal muscles, and adipose tissues were assayed for dry matter, total lipids, and fatty acid composition.

Results and Discussion

Growth and performance characteristics are shown in table 3. Average daily feed intake decreased linearly as the amount of calories from fat was increased in the diets. Conversely, feed efficiency and efficiency of

lean gain both increased linearly as increasing amounts of fat were added to the diet. Pigs fed all treatments exhibited similar average daily gain and average daily energy intake. Body composition data revealed that slightly less lean and a little more fat were incorporated into the carcass as the fat content of the diet was increased (table 4).

The fatty acid composition of the longissimus muscle from finishing pigs fed diets containing choice white grease or soybean oil is shown in table 5. The addition of choice white grease as an energy source in the diets of pigs did not change the amount of saturated fatty acids, monounsaturated fatty acids, and polyunsaturated fatty acids in the longissimus muscle. When soybean oil, however, was included as an energy source in the diets of pigs, saturated fatty acids and monounsaturated fatty acids decreased linearly as the amount of soybean oil in the diet increased. Most of the change in saturated fatty acids was

Table 2. Fatty acid composition of choice white grease and soybean oil.

	CWG	SBO
Fatty Acid ^a		
14:0	1.37	.03
15:0	.07	ND
16:0	26.1	10.4
16:1	2.94	.08
17:0	.38	.07
17:1	.35	.03
18:0	11.0	4.2
18:1 t n-9	1.34	ND
18:1 c n-9	44.1	22.4
18:2	11.7	55.3
18:3 n-3	.22	7.30
20:0	ND	.16
20:1	.20	ND
20:2	.11	ND
SFA	39.0	14.9
MUFA	48.9	22.5
PUFA	12.1	62.6
P:S	.31	4.20
U:S	1.56	5.71

^aFatty acids are reported as a percentage of total fatty acids identified: SFA = total saturated fatty acids, MUFA = total monounsaturated fatty acids, PUFA = total polyunsaturated fatty acids, P:S = ratio of total polyunsaturated to total saturated fatty acids, U:S = ratio of total unsaturated (mono and poly) to total saturated fatty acids.

ND = not detected.

due to a decrease in palmitate. Oleic acid was largely responsible for the decrease in monounsaturated fatty acids. Polyunsaturated fatty acids increased by more than 100% in the longissimus muscle of pigs as soybean oil was increased to 40% of total calories. The change in polyun-

saturated fatty acids was seen as a result of the large increase in linoleic acid.

Fatty acid composition of the triceps brachii muscle (table 6) and fatty acid composition of the biceps femoris muscle (table 7) revealed similar responses to those of longissimus muscle. The longissimus muscle, however, was more saturated, more monounsaturated, and less polyunsaturated than either the triceps brachia muscle or the biceps femoris muscle.

References

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Table 1. Composition of diets.

Item	Diets ^a								
	Control	10%CWG	20%CWG	30%CWG	40%CWG	10%SBO	20%SBO	30%SBO	40%SBO
Ingredients, % as fed									
Ground shelled corn	85.84	78.22	69.68	60.03	49.05	78.07	69.40	59.62	46.20
Soybean meal ^b	12.30	15.25	18.53	22.23	26.47	15.21	18.44	22.08	24.93
Choice white grease	-	4.67	9.91	15.84	22.60	-	-	-	-
Solka flocc ^c	-	-	-	-	-	-	-	-	4.68
Soybean oil ^d	-	-	-	-	-	4.86	10.29	16.41	22.22
Calcium Carbonate	.92	.90	.88	.85	.81	.89	.86	.84	.78
Dicalcium Phosphate	.42	.45	.48	.52	.55	.46	.49	.54	.67
Salt	.27	.26	.27	.28	.27	.26	.27	.27	.28
TM and Vit Mix ^e	.25	.25	.25	.25	.25	.25	.25	.25	.25
Calculated nutrient values									
ME ^f (Mcal./kg.)	3.353	3.546	3.766	4.011	4.289	3.539	3.747	3.980	4.042
Protein	13.3	14.0	14.9	15.9	17.0	14.0	14.8	15.8	16.0
Analysis									
Lipids, %	2.19	5.86	10.31	15.76	19.64	6.31	10.79	15.62	22.59
DM, %	87.33	88.73	90.23	91.74	86.99	88.01	89.97	90.91	92.61

^aAbbr.: 10%, 20%, 30%, and 40% refer to amount of calories in diet from lipids; CWG = choice white grease; SBO = soybean oil.

^b48% crude protein.

^cFiber Sales and Development Corp., Urbana, OH.

^dCentral Soya, Inc., Fort Wayne, IN, donated through the courtesy of D. Strayer.

^eCommercial trace mineral and vitamin mix contains (per kg.): 33.4 g. calcium, 109 g. magnesium, 4 g. copper, 410 mg. iodine, 32 g. iron, 16 g. manganese, 120 mg. selenium, 32 g. zinc, 160 mg. cobalt, 2220 KIU vitamin A, 709 KIU vitamin D₃, 6.72 KIU vitamin E, 883 mg. vitamin K, 201 mg. menadione (synthetic vitamin K), 38,269 mg. choline, 44,089 mg. choline chloride, 14,108 mg. niacin, 7067 mg. d-pantathenic acid, 1776 mg. riboflavin, and 11 mg. vitamin B₁₂. This premix was added at a rate of 25 g./10 kg. feed, as-fed basis.

^fMetabolizable Energy.

Table 3. Growth and performance characteristics of finishing pigs fed diets containing choice white grease or soybean oil^a.

Item	Treatments ^b										Contrasts ^c	
	Control	10%CWG	20%CWG	30%CWG	40%CWG	10%SBO	20%SBO	30%SBO	40%SBO	SEM ^{de}	CWG	SBO
ADFI ^f (kg./d)	3.14 ^L	2.83 ^{Lmno}	2.96 ^{Lmn}	2.58 ^{nop}	2.17 ^q	3.01 ^{Lm}	2.71 ^{mnop}	2.48 ^{opq}	2.35 ^{pq}	.14 ^d	***	***
ADG ^g (kg./d)	.88	.85	1.03	.98	.89	.92	.96	.92	.93	.07 ^d		
Feed Efficiency ^h (g./kg.)	276 ⁿ	295 ⁿ	347 ^m	381 ^{Lm}	403 ^L	307 ⁿ	354	370 ^{Lm}	394 ^L	13 ^d	***	***
ADEI ⁱ	11.9 ^{Lm}	11.3 ^{Lmn}	12.4 ^L	11.5 ^{Lmn}	10.2 ⁿ	11.9 ^{Lm}	11.3 ^{Lmn}	10.9 ^{Lmn}	10.4 ^{mn}	.57 ^d		
Efficiency of Lean gain ^k (g./kg.)	97 ^p	105 ^{op}	113 ^{nop}	131 ^{Lm}	116 ^L	110 ^{op}	120 ^{mno}	127 ^{Lmn}	128 ^{Lm}	6.1 ^e	***	*

^aLeast squares means and contrasts.

^bAbbr.: 10%, 20%, 30%, and 40% refer to amount of calories in diet from lipids; CWG = choice white grease; SBO = soybean oil.

^cContrast = linear by amount of dietary lipid.

^dn=6 for all treatments.

^en=6 for all treatments, except for 40% CWG n=5.

^fADFI = average daily feed intake.

^gADG = average daily gain.

^hFeed efficiency = gain per feed intake.

ⁱADEI = average daily energy intake, ADEI = ADFI x calculated metabolizable energy (Mcal./kg.)

^jEfficiency of lean gain (g./kg.) = LDOT (lean gain per day on test)/ADFI.

^kGrisdale, et al., 1984.

^{Lmnopq}Means in the same row with a different superscript differ (P < .05).

*P < .05

***P < .001

Table 4. Carcass characteristics and composition of finishing pigs fed diets containing choice white grease or soybean oil^a.

Item	Treatments ^b									SEM ^{cd}
	Control	10%CWG	20%CWG	30%CWG	40%CWG	10%SBO	20%SBO	30%SBO	40%SBO	
Tenth rib backfat, cm.	2.50	2.41	2.94	2.99	2.93	2.54	2.58	2.56	2.94	.32
Lean color score ^e	2.83	2.83	3.00	2.83	2.35	2.67	2.83	3.00	2.67	.17
Marbling score ^f	2.67	2.67	2.83	2.50	2.33	2.67	2.00	2.83	2.33	.27
Lean firmness score ^g	2.83	2.50	2.83	2.67	2.35	2.50	2.33	2.83	2.17	.27
Carcass weight, kg.	80.7	81.2	83.9	85.2	83.6	83.4	83.4	82.1	82.3	1.0
Carcass length, cm.	80.8	81.1	81.5	81.3	81.1	81.9	81.8	82.6	80.7	.9
Dressing, %	74.2	74.3	74.9	75.1	74.3	74.8	74.3	73.6	74.1	.5
LDOT ^h , g./d	298	298	333	338	313	328	321	315	306	18
Longissimus muscle area, cm. ²	38.2	35.6	37.6	38.02	38.3	39.7	38.1	35.8	35.0	2.1
Composition										
Lean, %	50.2	47.3	48.0	46.0	48.5	48.2	48.1	48.4	46.9	1.9
Fat, %	30.7	32.9	33.5	36.6	33.1	33.7	33.8	31.6	34.7	2.1
Bone, %	13.8	14.9	13.9	12.4	13.3	13.0	13.7	14.7	13.5	.6
Skin, %	5.33	4.89	4.67	4.91	5.18	5.10	4.50	5.27	4.87	.26

^aLeast squares means.

^bAbbr.: 10%, 20%, 30%, and 40% refer to amount of calories in diet from lipids; CWG = choice white grease; SBO = soybean oil.

^cStandard error of the mean.

^dn = 6 for all treatments, except for 40% CWG n = 5.

^eScores: 1 to 5; 2 = gray, 3 = light pink.

^fScores: 1 to 5; 1 = pale, 5 = dark.

^gScores: 1 to 5, 2 = firm, 3 = slightly firm.

^hLDOT = Lean produced per day on test, Grisdale et al., 1984.

Table 5. Fatty acid composition, and lipid and dry matter content of longissimus muscle from finishing pigs fed diets containing choice white grease or soybean oil^a.

Item	Treatments ^b										Contrasts ^c	
	Control	10%CWG	20%CWG	30%CWG	40%CWG	10%SBO	20%SBO	30%SBO	40%SBO	SEM ^d	CWG	SBO
Fatty acids ^e												
14:0	1.33 ^{kl} ***	1.28 ^{klm}	1.32 ^{kl}	1.37 ^k	1.36 ^k	1.37 ^k	1.19 ^{lm}	1.14 ^m	.97 ⁿ	.055		
16:0	27.5 ^k	26.9 ^k	26.4 ^k	26.0 ^{kl}	26.1 ^{kl}	26.8 ^k	24.5 ^l	22.3 ^m	19.3 ⁿ	.65		***
16:1	4.06 ^k	4.10 ^k	3.98 ^{kl}	3.80 ^{kl}	3.50 ^l	3.81 ^{kl}	2.87 ^m	2.83 ⁿ	1.94 ⁿ	.18		***
18:0	12.28 ^k	12.00 ^{kl}	11.19 ^{kl}	11.01 ^{lm}	11.24 ^{kl}	11.74 ^{kl}	11.48 ^{kl}	10.07 ^m	8.73 ⁿ	.40		***
18:1	43.2 ^{kl}	46.0 ^k	45.2 ^k	44.4 ^{kl}	40.8 ^{lm}	39.1 ^m	38.5 ^m	32.5 ⁿ	31.6 ^o	1.37	*	***
18:2	7.4 ^k	6.8 ^k	8.1 ^k	9.9 ^{kl}	12.8 ^l	12.6 ^l	16.6 ^m	25.8 ⁿ	31.4 ^o	1.24	**	***
18:3	.19 ^p	.19 ^p	.33 ^p	.25 ^p	.54 ^{pq}	.60 ^{pq}	1.03 ^q	2.41 ^r	3.16 ^s	.18		***
Total SFA ^f	41.4 ^k	40.4 ^{kl}	39.2 ^{klm}	38.6 ^{lm}	39.0 ^{klm}	40.2 ^{klm}	37.4 ^m	33.8 ⁿ	29.3 ^o	1.03		***
Total MUFA ^g	49.8 ^{kl}	51.7 ^k	51.0 ^k	50.2 ^k	46.4 ^l	45.0 ^m	43.5 ^m	36.1 ⁿ	34.6 ⁿ	1.26	*	***
Total PUFA ^h	8.8 ^k	8.0 ^k	9.8 ^k	11.2 ^{kl}	14.6 ^l	14.8 ^l	19.1 ^m	30.0 ⁿ	36.1 ^o	1.45	**	***
P:S	.21 ^{kl}	.20 ^k	.25 ^{kl}	.29 ^{kl}	.38 ^{lm}	.38 ^{lm}	.52 ^m	.90 ⁿ	1.26 ^o	.059		***
U:S	1.42 ^k	1.48 ^{kl}	1.57 ^{kl}	1.60 ^{kl}	1.58 ^{kl}	1.50 ^{kl}	1.68 ^l	1.97 ^m	2.44 ⁿ	.079		***
Lipids, %	3.24 ^{kl}	3.82 ^k	3.25 ^{kl}	3.47 ^k	3.18 ^{kl}	2.47 ^l	2.60 ^l	3.07 ^{kl}	3.46 ^k	.28	*	*
DM ⁱ , %	26.92	27.01	26.42	26.80	27.43	26.25	26.14	26.55	26.68	.32		

^aLeast squares means and contrasts.

^bAbbr.: 10%, 20%, 30%, and 40% refer to amount of calories in diet from lipids; CWG = choice white grease; SBO = soybean oil.

^cContrast = linear by amount of dietary lipid.

^dn = 6 for all treatments, except for 40% CWG n = 5.

^eFatty acids are reported as a percentage of total fatty acids, SFA = total saturated fatty acids, MUFA = total monounsaturated fatty acids, PUFA = total polyunsaturated fatty acids, P:S = ratio of total polyunsaturated to total saturated fatty acids, U:S = ratio of total unsaturated (mono and poly) to total saturated fatty acids.

^fAlso includes 15:0, 17:0, 20:0, and 22:0.

^gAlso includes 15:1, 17:1, 20:1, and 22:1.

^hAlso includes 20:3, 20:4, 22:2, and 22:6.

ⁱDM = dry matter.

^{klmno}Means in the same row with a different superscript differ (P < .05).

^{pqrs}Means in the same row with a different superscript differ (P < .01).

*P < .05

**P < .01

***P < .001

Table 6. Fatty acid composition of triceps brachii muscle from finishing pigs fed diets containing choice white grease or soybean oil^a.

Item	Treatments ^b										Contrasts ^c	
	Control	10%CWG	20%CWG	30%CWG	40%CWG	10%SBO	20%SBO	30%SBO	40%SBO	SEM ^d	CWG	SBO
Fatty acids ^e												
14:0	1.06 ^{jk}	1.03 ^{jk}	1.08 ^{jk}	1.06 ^{jk}	.94 ^{kl}	1.10 ^j	.90 ^{kl}	.78 ^l	.52 ^m	.064		***
16:0	24.7 ^o	23.9 ^o	23.8 ^o	23.3 ^o	24.3 ^o	23.2 ^o	20.5 ^p	19.2 ^{pq}	17.6 ^q	.63		***
16:1	3.36 ^j	3.44 ^j	3.52 ^j	3.24 ^{jk}	2.87 ^k	3.08 ^{jk}	2.04 ^l	1.57 ^m	1.21 ^m	.17	*	***
18:0	11.2 ^j	10.8 ^j	10.5 ^j	10.3 ^{jk}	10.7 ^j	10.7 ^j	10.4 ^{jk}	9.5 ^{kl}	9.0 ^l	.36		***
18:1	37.3 ^{kl}	41.8 ^j	41.6 ^j	41.3 ^{jk}	35.0 ^{lm}	36.9 ^{kl}	31.9 ^{mn}	29.5 ⁿ	28.9 ⁿ	1.7	*	***
18:2	14.1 ^{kl}	12.1 ^k	13.5 ^{kl}	14.8 ^{kl}	18.0 ^{jl}	18.1 ^j	26.4 ^m	32.1 ⁿ	33.2 ⁿ	1.6	*	***
18:3	.44 ^j	.28 ^j	.32 ^j	.38 ^j	.49 ^j	.99 ^j	1.96 ^k	3.15 ^l	3.71 ^l	.28		***
Total SFA ^f	37.5 ^j	36.2 ^j	35.8 ^j	35.0 ^j	36.4 ^j	35.5 ^j	32.3 ^k	29.9 ^{kl}	27.4 ^l	.9		***
Total MUFA ^g	44.1 ^{jk}	47.5 ^j	47.4 ^j	46.8 ^j	41.1 ^k	42.1 ^k	35.8 ^l	32.7 ^l	31.9 ^l	1.7	*	***
Total PUFA ^h	18.4 ^{jk}	16.3 ^j	16.9 ^j	18.2 ^{jk}	22.5 ^k	22.4 ^k	31.9 ^l	37.5 ^m	40.7 ⁿ	1.8	*	***
P:S	.49 ^j	.45 ^j	.47 ^j	.52 ^j	.62 ^j	.64 ^j	1.00 ^k	1.28 ^l	1.52 ^m	.075		***
U:S	1.67 ^j	1.76 ^j	1.80 ^j	1.86 ^j	1.77 ^j	1.84 ^j	2.12 ^k	2.37 ^l	2.68 ^m	.089		***

^aLeast squares means and contrasts.

^bAbbr.: 10%, 20%, 30%, and 40% refer to amount of calories in diet from lipids; CWG = choice white grease; SBO = soybean oil.

^cContrast = linear by amount of dietary lipid.

^dn = 6 for all treatments, except for 40% CWG n = 5.

^eFatty acids are reported as a percentage of total fatty acids, SFA = total saturated fatty acids, MUFA = total monounsaturated fatty acids, PUFA = total polyunsaturated fatty acids, P:S = ratio of total polyunsaturated to total saturated fatty acids, U:S = ratio of total unsaturated (mono and poly) to total saturated fatty acids.

^fAlso includes 15:0, 17:0, 20:0, and 22:0.

^gAlso includes 15:1, 17:1, 20:1, 22:1, and 24:1.

^hAlso includes 20:2, 20:3, 20:4, 22:2, and 22:6.

^{ijklmn}Means in the same row with a different superscript differ (P < .05).

^{opq}Means in the same row with a different superscript differ (P < .01).

*P < .05

***P < .001

Table 7. Fatty acid composition of biceps femoris muscle from finishing pigs fed diets containing choice white grease or soybean oil^a.

Item	Treatments ^b										Contrasts ^c	
	Control	10%CWG	20%CWG	30%CWG	40%CWG	10%SBO	20%SBO	30%SBO	40%SBO	SEM ^d	CWG	SBO
Fatty acids ^e												
14:0	1.10 ^{jk}	1.23 ^j	1.20 ^{jk}	1.04 ^k	1.15 ^{jk}	1.23 ^j	1.03 ^k	.84 ^l	.74 ^l	.068		***
16:0	25.0 ^{jk}	25.4 ^j	24.6 ^{jk}	23.6 ^k	24.4 ^{jk}	24.6 ^{jk}	21.8 ^l	19.9 ^m	17.9 ^m	.61		***
16:1	3.70 ^{jk}	3.79 ^j	3.85 ^j	3.24 ^k	3.24 ^k	3.51 ^{jk}	2.51 ^l	1.72 ^m	1.60 ⁿ	.18	*	***
18:0	10.6 ^{jk}	10.8 ^j	9.6 ^{klmn}	9.1 ^{mn}	9.8 ^{klm}	10.2 ^{kl}	9.3 ^{lmn}	8.6 ^{no}	7.7 ^o	.38		***
18:1	39.8 ^{jl}	44.4 ^k	43.0 ^{jk}	42.0 ^{jk}	40.5 ^{jkl}	37.3 ^{lm}	34.9 ^m	28.9 ⁿ	28.4 ⁿ	1.7		***
18:2	13.0 ^{jk}	10.4 ^j	12.7 ^{jk}	14.7 ^{kl}	14.5 ^{kl}	17.6 ^l	24.5 ^m	32.8 ⁿ	36.3 ^o	1.2	*	***
18:3	.28 ^j	.16 ^j	.23 ^j	.32 ^j	.29 ^j	.68 ^k	1.74 ^l	2.69 ^m	3.41 ⁿ	.12		***
Total SFA ^f	37.0 ^j	37.7 ^j	35.7 ^{jk}	34.1 ^{kl}	35.8 ^{jk}	36.4 ^{jk}	32.4 ^l	29.6 ^m	26.6 ⁿ	1.0		***
Total MUFA ^g	47.5 ^j	50.4 ^j	50.0 ^j	48.9 ^j	47.0 ^{jk}	43.6 ^k	39.5 ^l	33.2 ^m	32.0 ^m	1.4		***
Total PUFA ^h	15.5 ^{jk}	11.9 ^j	14.3 ^{jk}	17.0 ^{kl}	17.1 ^{kl}	19.9 ^l	28.1 ^m	37.2 ⁿ	41.3 ^o	1.5	*	***
P:S	.42 ^{jk}	.32 ^j	.40 ^{jk}	.50 ^k	.47 ^{jk}	.56 ^k	.88 ^l	1.27 ^m	1.58 ⁿ	.064		***
U:S	1.71 ^{jk}	1.65 ^j	1.82 ^{jk}	1.93 ^{kl}	1.80 ^{jk}	1.77 ^{jk}	2.11 ^l	2.40 ^m	2.78 ⁿ	.082		***

^aLeast squares means and contrasts.

^bAbbr.: 10%, 20%, 30%, and 40% refer to amount of calories in diet from lipids; CWG = choice white grease; SBO = soybean oil.

^cContrast = linear by amount of dietary lipid.

^dn = 6 for all treatments, except for 40% CWG n = 5.

^eFatty acids are reported as a percentage of total fatty acids, SFA = total saturated fatty acids, MUFA = total monounsaturated fatty acids, PUFA = total polyunsaturated fatty acids, P:S = ratio of total polyunsaturated to total saturated fatty acids, U:S = ratio of total unsaturated (mono and poly) to total saturated fatty acids.

^fAlso includes 15:0, 17:0, and 20:0, and 22:0.

^gAlso includes 15:1, 17:1, and 20:1, 22:1, and 24:1.

^hAlso includes 20:3, 20:3, 20:4, 22:2, and 22:6.

^{ijklmno}Means in the same row with a different superscript differ (P < .05).

*P < .05

***P < .001